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Metabolic limitations to photosynthetic efficiency of sorghum seedling leaves at low temperature

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Abstract

In view of the effects of global climate changes on plant growth conditions in Europe, specific traits of sorghum make it a promising candidate for a future bioenergy crop in this region. The main limiting factor seems to be low tolerance of sorghum seedlings to chilling temperature and possible damage caused by cold spells in April and May.

Seedlings of six sorghum genotypes (M71/SS79/Etian/Keller/Ji2731/Btx623) at third-leaf stage were exposed to five-day chilling (13/10°C, day/night) in a growth chamber and then recovered for five days at control temperature (25/20°C). Before and during cold treatment as well as during recovery, photosynthetic efficiency (PE), stomata status, and osmotic potential (OP) were measured for the first three leaves.

As early as after 4 h of chilling there was a significant drop in PE measured as chlorophyll *a* fluorescence parameters, which decreased further in the course of chilling with significant genotypic differences. These were particularly pronounced after five-day recovery – M71 and Ji2731 recovered almost fully while SS79, Keller, and Btx623 – to a very limited degree. In these susceptible lines a significantly bigger drop in PE was observed for the first (oldest) leaf compared to the third (youngest) one, whereas in the tolerant lines these differences were not significant. All genotypes exhibited stomata closure as late as the fifth chilling or first recovery day and a drop in leaf OP after 52 h of chilling.

The results show that the fast and significant drop in PE of sorghum seedlings under chilling conditions is caused by metabolic (non-stomatal) limitations during exposure to low temperature and by stomatal limitations after its cessation. The most pronounced genotypic differences in the reaction of sorghum seedlings to chilling stress were in the extent of osmotic adjustment and the capability for PE recovery after chilling treatment.

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